NAS Infrastructure Management System Build 1.5 Computer-Human Interface Final Report

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16. Abstract

Human factors engineers from the National Airspace System (NAS) Human Factors Branch (ACT-530) of the Federal Aviation Administration William J. Hughes Technical Center conducted an evaluation of the NAS Infrastructure Management System (NIMS) Build 1.5 computer-human interface (CHI) software. They conducted the evaluation at the NIMS Premier Facility (NPF) during November 1998. Five Airway Facilities Specialists serving as representative users employed scripts exercising the three applications that comprise NIMS Build 1.5. This software represented an interim build, and the NPF server did not represent the anticipated final configuration. This placed limits on the scope and content of the evaluation. The results of the evaluation indicated that system functionality could be improved by addressing several CHI areas. The human factors engineers determined that NIMS Build 1.5 has the potential to support an Operations Control Center Specialist in a centralized monitoring and control facility. However, at its tested maturity level, it was not capable of providing this support in an operational environment. They concluded that the majority of issues identified could be mitigated through the application of human engineering principles.

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Executive Summary

This document reports the results of the evaluation of the National Airspace System (NAS) Infrastructure Management System (NIMS) Build 1.5 computer-human interface (CHI) software. Human factors engineers from the Federal Aviation Administration (FAA) William J. Hughes Technical Center NAS Human Factors Branch (ACT-530) conducted the evaluation at the NIMS Premier Facility (NPF) in Herndon, Virginia from November 16 to 19, 1998. Five Airway Facilities (AF) Specialists, serving as representative users, and three human factors engineers, serving as expert observers, participated in the evaluation.

The goal of the evaluation was to identify CHI issues prior to completing software development. The evaluation employed a structured walk-through technique with the users providing comments as they performed test scripts. These test scripts exercised the three software applications that compose NIMS Build 1.5. In parallel, the observers provided relevant human factors comments.

ACT-530 staff organized and analyzed the comments obtained from the users and observers. The results of the evaluation identified several issues that would improve system functionality. Four major issues include

a. integrating the three software components,

b. providing the correct information needed to support task performance,

c. handling error messages and error management, and

d. providing proper and sufficient feedback regarding user and system actions.

The AF Specialists in the study indicated that at its current level of maturity, NIMS Build 1.5 was not capable of providing this support in an operational environment. However, they anticipated that if the issues they identified were addressed, a future build of NIMS had the potential to support a centralized monitoring and control facility. The human factors engineers concluded that the majority of issues identified could be mitigated through the application of human factors principles.

1. Introduction

At the request of the National Airspace System (NAS) Infrastructure Management System (NIMS) Product Team, human factors engineers from the NAS Human Factors Branch (ACT-530) of the Federal Aviation Administration (FAA) William J. Hughes Technical Center conducted an evaluation of NIMS Build 1.5 software. This report summarizes the results of the usability evaluation conducted in conjunction with the NAS Operations NIMS Program Office (AOP-30) during the week of November 16, 1998. It identifies and systematically classifies the human factors issues identified regarding the Build 1.5 NIMS computer-human interface (CHI).

The evaluation was conducted at the NIMS Premier Facility (NPF) in Herndon, Virginia. The NPF serves as the site to consider the viability of NIMS functionality in terms of user acceptance and productivity (FAA, 1998b). This evaluation reviewed the NIMS Specialist interface in terms of usability and applicable CHI standards contained in the Airway Facilities (AF) Human Factors Design Guide (HFDG) (Wagner, Birt, Snyder, & Duncanson, 1996) and other relevant human factors sources.

1.1 Background

The goal of the NIMS Program is to transition from a decentralized organization focused on equipment maintenance to a more centralized organization focusing on service management, prioritizing actions on the basis of operational significance, and improving service to users and customers. The NIMS Program leverages new technologies to enhance the efficiency and effectiveness of NAS infrastructure management. Specifically, it implements a new approach focused on the principles of service management, nationwide operations planning and oversight, centralized operational control, consolidated expertise, remote management of equipment, integrated information infrastructure, and collaborative decision making. The NAS infrastructure operations and maintenance concept calls for establishing an operations environment consisting of one National Operations Control Center, three Operations Control Centers, and a larger number of Work Centers (FAA, 1997). The NIMS Program will provide automation support services for the management of the NAS infrastructure (FAA, 1998b).

1.2 Scope and Limitations

This evaluation is limited to an assessment of the usability of Build 1.5 of the NIMS Specialist interface. Build 1.5 is a selected subset of several capabilities, which the FAA compiled from the *NIMS System/Segment Specification (SSS)* (FAA, 1998c). It represents a subset of functionality to be contained in NIMS Build 2. This report focuses on the ability of the user interface to support the specialist tasks. Data on the safety, efficiency, performance, and workload levels associated with this design were not collected. These data represent the type of evaluations that may be conducted when the system nears maturity.

The following list itemizes the specific limitations to this evaluation:

a. The overall NIMS software involved three major applications: Maximo, Maintenance Automation System Software (MASS), and ArcView. All come from different sources and only minimal integration had been accomplished.

b. The Maximo software was not in its final form. Several modifications to the commercial product, which were required to meet final FAA requirements, were not yet accomplished.

c. The system server was a smaller, more limited one than planned for operational use.

d. A significant software element, the Security and User Access module, was not in use.

e. The absence of some planned components such as on-line help and on-line technical manuals made evaluation of related operations impossible.

f. The database used was minimally populated.

g. The users and observers received minimal training on the system prior to the evaluation.

2. Method

This evaluation employed a methodology that ACT-530 had developed and refined to determine the CHI usability of FAA systems.

2.1 Participants

Two groups participated in the evaluation simultaneously. The first group consisted of five representative users recruited by AOP-30. The second group consisted of human factors engineers from ACT-530 who provided human factors observations. Table 1 provides the information for both groups.

Table 1. Participant Background Information

Position	Region
AT Systems Specialist	Southwest
AT Systems Specialist	Western-Pacific
AT Systems Specialist	Southern
NAS Operations Manager	Northwest Mountain
NAS Operations Manager	Great Lakes
Human Factors Engineers (3)	Technical Center

2.2 Materials

The equipment used to conduct the evaluation consisted of hardware and software located at the NPF and the video capture equipment supplied by ACT-530. Table 2 identifies this equipment.

Table 2. Test Equipment

Hardware	Software
OCC workstations each consisting of • Pentium PC • 128 MB RAM • 2 GB Hard Drive • 3COM 10/100 Ethernet, PCI Adapter • 17" Color Monitor • 104 Key Keyboard • 12/24X SCSI CD-ROM • 1.44 MB Floppy Drive	Software loaded on each OCC workstation • Windows NT Server 4.0 (Service package 3) • Oracle Client 7.3.2.2.0 • MAXIMO version 4.0 Build 1.5 • MASS version 1.0.041 • ArcView • Microsoft Office 97 • Norton AntiVirus
Screen capture equipment • Scan Converter • Video Recorder • Microphone	

ACT-530, working in conjunction with AOP-30, developed six test scripts (Appendix A) to exercise selected functionality present in the Build 1.5 NIMS Specialist interface. ACT-530 and AOP-30 developed them from procedures contained in the *NIMS NPF Integration Test Plan and Procedures* (FAA, 1998a) and other relevant materials. The first three scripts stepped participants through the functionality of MASS, ArcView, and MAXIMO. The remaining three scripts represented end-to-end tasks using a combination of all three applications. Script four addressed alarm detection, Candidate Event Ticket (CET) generation, and Event Ticket (ET) generation. Scripts five and six walked the participants through the procedure to build new ETs and create and track workforce schedules.

2.3 Schedule

Table 3 provides the schedule for this evaluation.

Table 3. NIMS Build 1.5 CHI Evaluation Schedule

Time	November 17	November 18	November 19
Morning	NIMS Build 1.5 orientation Human factors overview Self-paced walk-through of scripts	Self-paced walk-through of scripts Observation of interactions	Self-paced walk-through of scripts Observation of interactions Usability questionnaire
Afternoon	Self-paced walk-through of scripts Observation of interactions	Self-paced walk-through of scripts Observation of interactions	Debrief

2.4 Procedure

This evaluation employed a structured walk-through technique. The method consisted of users following scripts exercising common tasks and providing comments. In parallel, the human factors observers reviewed the interface against accepted human factors practices. The users completed a Post-Usability Evaluation Questionnaire (Appendix B) at the conclusion of all test scripts. The questionnaire assessed specific human factors aspects of the specialist interface including screen design, data entry, error messages, and input and control devices. The observers used a scan converter and video recorder to capture screen activity on a selected workstation while a participant completed the scripts. The observers reviewed this videotape during the data analysis activities.

The users performed the scripts independently on each of the five available OCC workstations at the NPF. At the conclusion of all test scripts, they completed the questionnaire. The observers reviewed the NIMS Build 1.5 Specialist interface while users performed the test scripts. This review included an evaluation of the interface with respect to human factors guidelines contained in the HFDG (Wagner et al., 1996) and other relevant sources.

At the conclusion of the study, the observers integrated all comments and questionnaire responses and performed a content analysis. They compiled and categorized the resulting list of items into relevant human factors issues. These are presented in the following sections.

3. Results and Discussion

The participants provided approximately 350 comments. The human factors engineers integrated and categorized the comments and conducted a human factors guideline review. They classified the issues into the following categories: general, basic screen design and operation, data entry, data display, user access, and help.

3.1 General

Most users indicated on the questionnaire that the system effectively supported their ability to manage resources, communicate, and generate reports. Two rated the system as adequate in terms of supporting coordination. However, all agreed that the current design was not acceptable. It required too much interaction and typing and had too many software problems. Though they considered the system to be very capable, they felt it would require significant changes before it could be fielded. Overall, the users were not satisfied with any of the functionality in its current state. Some users acknowledged that their review was hampered by the lack of a fully populated database and recommended that a complete national database be available for future evaluations.

The users commented on the lack of integration between the three applications. For example, when a loss of redundancy or other event was represented in ArcView, they found it cumbersome to identify the corresponding ET in the Maximo CET database. They were required to scroll through a long list of CETs to locate the appropriate one. When required to review or take control of the data stream from that facility, they had to open MASS and filter through all national facilities to locate the appropriate selection. As another example, when MASS alarms were acknowledged and notes were made, these notes were not available to Maximo.

In addition to these broad issues, the users and the observers commented on other aspects of the system such as input devices, response time, feedback, error messages, database population and maintenance, and software bugs. These are addressed below.

3.1.1 Input Devices

The users indicated that the keyboard and mouse worked well for all tasks (including data entry and cursor positioning). As an example, Maximo accepted both keyboard and mouse inputs interchangeably in date and time fields.

3.1.2 System Response Time

The NPF server used during this evaluation was not representative of the anticipated final configuration. The user comments regarding system response times in the following paragraph are provided to highlight the need for adequate server response times in future systems. All users indicated that the system response times were not acceptable.

Initial load times for ArcView, a graphics-intensive application, required approximately 15 minutes, 1½ minutes to add a group, and up to several seconds to refresh a screen. Most users indicated that selecting the terminal, radar, or remote options from the ArcView drop down list (step 2.1f of the script) was especially slow, taking an estimated 2 minutes or more to load for each option. Initial load times for Maximo screens ranged from 1 to 3 minutes, and subtabs took approximately 12 seconds to load. One user reported that Maximo refresh rates, after initial loading, were acceptable. Some users found MASS response times to be slow. Observation of the videotapes indicated that logging on to the MASS system took approximately 12 seconds and that screen updates took about 2 seconds.

3.1.3 Feedback

The user did not always receive feedback on the status of a process. On the questionnaire, all users indicated that they were often unaware of what the system was doing. The HFDG (Wagner et al., 1996) recommends that when system responses take more than 2 seconds, the user should be provided periodic feedback and a clear indication of when processing is complete. In many instances, ArcView and Maximo did not adequately provide this type of feedback. Users noted the following examples:

a. It took several minutes to load ArcView.

b. Users received no feedback regarding the loading status and, in many cases, had to minimize and remaximize the window at the completion of loading to begin using the application.

c. A user can open a new instance of ArcView without being alerted that they already have a copy opened.

d. When logging on to ArcView, the user is not notified that the password is case sensitive. This should be stated in the box where the password is entered or provided in response to a failed logon attempt.

e. When ArcView is minimized, there is no indication of alarm status or changes in alarm status.

f. Maximo did not notify the users when they were at the first ET and selected the “view previous ticket” icon.

g. Maximo does not always provide feedback when loading screens.

h. Maximo does not notify a user when an open ET is modified. Remote AF System Specialists and other personnel will frequently access and update ETs. Without some form of notification, the OCC user is unaware of which open ETs need to be refreshed. If the OCC user fails to update a modified ET, the change may go unnoticed for an extended period and have an impact on the delivery of NAS services.

3.1.4 Error Messages

Error messages hold significant implications for user performance. Shneiderman (1992) notes that in a review of five studies, improved error messages resulted in lower error rates, increased user satisfaction, and more success in repairing errors.

All of the participants indicated that error messages were not clear and that the messages did not summarize the problem or provide solutions. The messages referenced variables that were unfamiliar to the users and did not instruct them in how to recover from the error. The error messages were not given in language that the user could understand and did not give a clear indication of possible solutions. Examples of some error messages are provided.

a. When attempting to log on to ArcView, the system indicated *Variable cover Ftab has not been initiated*.

b. In response to selecting themes in ArcView, an error message appeared stating *Avenne Error: NFMD. Display Adjacent Radar Tool <Stop> Variable cover Ftab has not been initiated*.

c. When closing the ArcView location table, the following message was received—*Error. The script “NFMD, getAppLogIndex*” could not be found.

d. In some instances, when a user was attempting to change the status of an ET in Maximo (Step 4.4j), the system indicated *SQL Error: 904-ORA-00904: Invalid Column Name*. When they selected “more” to get additional information, they received the following sequel (SQL) statement: *select WONUM from WOsafetylink where NONUM = :fwonum and wosafetydatasoure=’WO’*.

e. When creating a Significant Event Report (SER) in Maximo (step 4.6e of the scripts), one user was informed that ET 1558 was not a significant event. The user was unsure how to proceed.

f. Another error message received in response to an attempt to print an SER stated *Report not generated*.

Many of the errors resulted in the need to reload the application or to reboot the workstation. The human factors engineers recommend that error messages follow the guidelines provided in the HFDG (Wagner et al., 1996) and that they be brief, informative, and provide specific direction to users on how to recover from an error. If required, the system may provide more than one level of error messages with successive levels providing more detail.

3.1.5 Database Population and Maintenance

The users acknowledged the value of many of the types of data available in the system. However, their major concern was identifying who would be responsible for entering and maintaining the data. The tasks of entering and updating the databases are extremely time intensive and require extensive manpower. One user identified the calendar as a particularly good tool but asked who would maintain the technician schedule and update overtime.

This concern may have been raised in part because the users represented potential OCC operators and many of the screens they viewed (e.g., accounting screens) represented information that they would most likely not use in an operational system. The human factors engineers recommend that a detailed review of the interface be conducted with other groups of representative users (e.g., administrative, training, analysis, and management) to identify specific screen content and format needs for each type of user.

3.1.6 Software Bugs

Although not the primary focus, during the evaluation, the participants identified several software bugs in the Maximo and ArcView applications:

a. On several occasions, when a user attempted to run a report or change the status of an action, Maximo returned the SQL error discussed previously. The source of this error message was not clear to the participants.

b. Selecting the help button when viewing the ET screen in Maximo resulted in the shut down of the application and the generation of an event log.

c. When running a report in Maximo (Step 4.6f of the script), values entered in the delay field screen were doubled.

d. In Maximo, when completing the ticket priority field of an ET, the default value is 5, but the available options are 1, 2, or 3.

e. When selecting the terminal drop down list in ArcView, one user received an error indicating that the variable cover Ftab had not been initiated.

3.2 Basic Screen Design and Operations

The basic principle of screen design and operation should be to support the performance of required tasks in the most efficient and effective manner. It includes the overall design, structure, and content of the individual screens; how the screens are used; and how users select and navigate among them.

Each of the following subsections addresses a particular aspect of screen design or operation. In all, there were 192 comments assigned to this category, and these were sorted into nine primary subcategories. Many of the issues are interrelated, so the comments may address more than one subcategory.

3.2.1 Consistency

A basic concept of CHI design is that any task, operation, or action should always be accomplished the same way throughout the system (Wagner et al., 1996, Sections 5.1.1 and 8.5.1). This helps minimize operator error, training requirements, and task loading. Changes should only occur when there is a substantive need to modify the item or object. Users should not have to remember multiple identifiers or names for a single object. Where a new system design must interface with existing (legacy) systems, an attempt should be made to be consistent with current practice unless significant changes in process or content require differentiation from the other systems.

Specialists and observers made several comments regarding consistency. Some of these were also relevant to other issues.

a. Capitalization during data entry was inconsistent. Some fields were case sensitive. The user had no way of knowing this except by memorization. In some cases, the user was unable to determine why the entry was not accepted until informed by someone else.

b. Each CET generated by MASS had an identification number. When accepted by the specialist as an ET, a different number was assigned. This made it difficult to trace the CET/ET history and relationship or to find out whether a given CET has been accepted or cancelled. This problem received multiple comments.

c. Use of the percent sign (%) as a wild card during text searches was available for some fields but not others. The user had no way of knowing whether a search failed because the field didn't accept the % symbol or for some other reason. The alternative is a global search, which may be slower and less productive.

d. Maximizing and minimizing the MASS window was performed differently than the other two software components.

e. Highlighting of fields when selected was not consistent.

These items can make system operation more difficult for a user. The human factors engineers recommend a review of the overall system software integration to determine the feasibility of modifications to promote internal consistency. Among the areas that should be considered are sensitivity to capitalization of data entry, event numbering, use of wild cards, window-resizing function, and highlighting.

3.2.2 Log On and Log Off

Log on and log off should be simple but precise. Where user ID is required, the process should provide good identification without extensive logging procedures (Wagner et al., 1996, Section 11.3). Where multiple applications are involved, additional effort should be made to minimize the number of separate log ons required when a user consistently uses the same set of applications. Because Build 1.5 uses three separate application packages and requires three separate log ons, this is of particular interest. Participants commented on the long loading times for ArcView and MASS and lack of feedback to the user as to loading status. The major issues raised regarding log on and log off were the following:

a. It was possible to accidentally log off from some processes that were running in the background without the user being informed.

b. Users had to log on to multiple programs with different passwords.

The human factors engineers recommend implementing a single, system-wide log on.

3.2.3 Simplicity

Screens and other displays should not contain extraneous, rarely used, or irrelevant data. Irrelevant data require the user to scan the material to select the relevant content. This slows performance and can generate errors. It can also annoy users and prevent their acceptance of the system.

Almost a third of all user comments addressed the presence of irrelevant content on the screens. It represented a major concern in this build. Additionally, many data tables were large and required extensive scrolling both vertically and horizontally. This slowed task performance and could generate errors. Examples of these issues include the following items:

a. The tabs associated with the ET tracking screens contained extensive costing data never used while processing an event.

b. The equipment location, ET list, and the MASS alarm tables provided inadequate filtering and search support.

This is a very significant operational problem. It clearly concerned the users, who recommended deletion of entire tabs, tables, and screens. The human factors engineers recommend that the screens and their content be tailored to support specific tasks and users. Not all personnel will perform all tasks. Therefore, providing an individual with unnecessary data adds needless complexity.

3.2.4 Labels, Titles, Wording, Borders, and Menus

Use of labels and titles should be consistent throughout a system (Wagner et al., 1996, Section 8.5.2). In NIMS, where commercial-off-the-shelf (COTS) software from three different vendors is being integrated, this becomes a significant issue. Wording used in the labels and titles should conform to the uses of the technical field involved. For example, in one case, an Event Ticket

(FAA term) was also referred to as a Work Order (common industrial term). An additional issue is that labels must be informative.

Menus are often the easiest means of accessing specific content. To be effective, menus must be limited in number and size and must have keyboard equivalents where appropriate. Correct wording and ease and speed of access are significant in menu design. The users and observers raised no major issues about menus. The relatively small number of comments were primarily related to Maximo and addressed

a. the presence of incorrect, confusing, or non-informative labels (these labels do not properly describe the field or content);

b. the use of abbreviations for location identifiers (because the sites monitored by an OCC will be geographically dispersed, specialists would need to look up or memorize the identifiers);

c. the use of non-FAA terminology such as references to process or ET "children;" and

d. the use of the same label for different content on many subsidiary screens. Most notably, the "drilldown" and "select value" titles are used for several very different content screens. It can result in users thinking they are in one screen when they are actually in another. This can generate errors.

We recommend reviewing the use of labels and abbreviations, particularly within Maximo, to verify they are used consistently and employ FAA terminology.

3.2.5 Window Controls

This subcategory addresses the use of scroll bars, up/down arrows, paging, pointers, and other means of navigating around a screen when all content cannot be displayed at one time. This issue received little direct comment, with the exception of the excessive need to use these controls, which is addressed in the Simplicity section.

This issue does not appear to have been a problem for the users or observers. Some adjustments would probably be helpful after other problems have been resolved.

3.2.6 Window States

ET windows can be in different operational states. This affects the ability of the user to enter, delete, or modify screen data. Maximo screens have four possible modes that affect data entry and use. The only indication of which mode is invoked is a small block at the lower left of the screen on the status bar. Due to the minimal training, users were largely unaware of these modes until attempts to perform some action incompatible with the mode failed. No user comments were received on this issue despite observers having noted a number of mode-related errors.

The human factors engineers recommend that users be made aware of what state or mode is active on the system and what each mode implies for operations. This issue is closely related to feedback and error management issues.

3.2.7 Window Navigation

Well-designed systems provide information for a task on a single screen and minimize the need to navigate between windows. In NIMS, where there are three major applications, good window navigation is essential. Navigation can be performed in several ways, commonly using menus or icons. Many guidelines for navigation have been established, which are included in Section 8.3 of the HFDG (Wagner et al., 1996). The users experienced little difficulty with navigation techniques. One issue was the need for extensive scrolling and the use of nested scroll bars. This made it easy to move the wrong one, unnecessarily displacing the data. Related issues include extensive scrolling and data transfer among screens.

The navigation techniques themselves did not pose a major problem. However, the amount of navigation required was significant and appeared to slow task performance. This is also related to screen content.

3.2.8 Coding

Coding is the use of symbols or other display characteristics to uniquely display data values, modify display elements, or as a "shorthand" means of displaying complex data. In graphic displays, shape, size, color, and motion are common coding dimensions. For text presentations, color, shape (italic, bold, etc.), and size are also used. Coding guidelines are available in Section 8.5.4 of the HFDG (Wagner et al., 1996).

Although coding was not consistent across the graphic and text applications, users were able to adapt to differences between the applications. It is unclear whether they would adapt as efficiently when faced with heavy operational loads. The few comments received addressed the ability to discriminate between different levels of coding or to detect changes in coding. The major color-coding issue was user difficulty in discriminating between some colors that were too similar or too faint to be easily differentiated.

In the text applications, the coding was relatively simple and largely limited to the color of the text or field. MASS also uses few symbolic codes. ArcView drew the majority of comments because much of its content is symbolic, and coding is used extensively. Overall, coding was acceptable. However, the system lacked consistency across applications and should be reviewed once screen content has been revised.

3.2.9 Matching System to User Needs

This section addresses whether the system provides the users with the information required to perform their tasks. If a user must search for information or make decisions and act without needed information, performance will be degraded. Good screen design demands a good understanding of the tasks being performed by the user both in terms of content and process. Besides screen design, navigation, coding, labeling, and many other factors also affect the availability and usability of information. More than half of the nearly 200 comments received on screen design and operation centered on matching the system to user needs. The following is a summary of major comments:

a. The presence of very large tables of data made it difficult for users to find needed information. In particular, comments centered on the data tables contained in the MASS alarm and alert table. These were organized by time, though some specialists needed it organized by site. Users had to search the entire list to find all the alerts and alarms at a site. They raised similar issues regarding the equipment tables and CET/ET lists.

b. When filtering was available, it was inconsistent and insufficient. The users reported that the number of steps required in MASS and Maximo was extensive and time intensive.

c. The users were unable to see changes in document or system data without refreshing the screens in Maximo. When data in the underlying database changed, the system did not notify the user. Any updates were not reflected unless the user refreshed the screen. Because these changes occurred on a random schedule, the user had to either repeatedly update the screen or receive notification of the change in some other way. They identified this as an issue particularly with respect to ET and equipment status.

d. Needed information was not easily accessible in Maximo. For example, the system did not provide a means for easily monitoring such variables as status of coordination approvals. The ET form did not provide information on whether approvals had been obtained or denied, and the user had to locate the information in other areas of the system.

e. Needed data were not available, primarily in ArcView. Some data considered important by the users were not present, including information on physical location and alarm information. This may have been due, at least in part, to the limited database provided for Build 1.5.

f. Data fields, in particular the use of time references, were inconsistent. In Maximo, both Zulu and local times were used, increasing the likelihood of confusion and forcing users to mentally translate times. FAA practice is to use Zulu time as a standard because operations occur across a number of time zones. This will be even more significant with the centralization of control at the three OCCs.

g. Identifiers were used inappropriately. In Maximo, a number of data items such as personnel lists were sorted by labor category code or other identifiers that are not used by specialists and may not even be known by them.

h. Users could not transfer data between applications. With three major applications from three different sources, it is essential to ensure the availability of data between applications to minimize the need for data reentry. Build 1.5 does not adequately support the transfer of data among the three applications.

The users indicated that much of the needed information was unavailable, required excessive effort to obtain, or was inappropriately formatted. This made the system difficult to use and interfered with user task performance. Nearly twice as many comments were provided on this than on any other subcategory.

3.3 Data Entry

Data entry is the process of inputting information into a system through the use of text fields or graphical controls. Section 8.1 of the HFDG (Wagner et al., 1996) provides recommendations for the design and operation of data entry methods. In addition to the concepts addressed in Section 3.2 of this document, data entry encompasses managing and preventing errors and minimizing data entry activities.

3.3.1 Text Fields

The users indicated that the mechanism to modify Maximo logs was cumbersome. Once entered, data were not easily edited. For example, to edit a work plan, they had to exit the log, re-open it, and then select ADD. Other examples included editing the date in the SER form and editing shifts in the Labor module (step 6.1g). Another concern was the lack of a spell check capability. OCC operators will enter significant amounts of information into ETs, and the ability to correct a spelling error before committing it to a log is highly desirable.

3.3.2 Graphical Controls

Graphical controls permit users to exercise control over system functions, components, or data structures. They include icons, push buttons, radio buttons, check boxes, and sliding scales. Overall, the graphical controls in Build 1.5 (i.e., icons, pushbuttons, and check boxes) were used effectively. Though the meaning of each icon was not immediately apparent to all users (e.g., the Maximo eraser icon), the availability of pop-up titles when users placed the cursor over the icon minimized concerns. The system should be reviewed to verify that pop-up titles or conveniently accessed descriptions are available whenever feasible.

3.3.3 Error Management and Prevention

Error management and prevention is a significant aspect of system performance. Shneiderman (1992) reported that 31% of professional users of text editing software made errors or used inefficient strategies.

Most users in this evaluation indicated that the data entry methods helped to minimize errors. Users easily differentiated between text entry and drop down lists. However, though sample inputs were provided near many data input fields, they were not available consistently across all applications or screens. For example, when preparing an SER (Step 4.6f), there was no format provided for entering the time of delay, causing one user to ask if the input should be reported in minutes, hours, or some other format.

The human factors engineers recommend that the system be reviewed to ensure that guidance is provided near the input field whenever feasible. When this cannot be accomplished, they suggest the provision of convenient access to information detailing the expected data input format. The HFDG, Section 8.1.5, provides recommendations regarding error management (Wagner et al., 1996).

The users had less favorable comments on detecting and correcting errors. Some reported that it was easy to detect data entry errors, but only one found it easy to correct these errors. One user indicated that when preparing a report using Maximo, the application accepted incorrectly formatted data, provided no feedback that the data were formatted inappropriately, and then failed to produce a report without providing an explanation. All of the participants felt that referencing systems specialists by labor codes instead of names was particularly awkward. One respondent pointed to this as a contributing cause of data input errors. In addition, users identified the preparation of SERs as a complex and error prone process.

All participants reported that NIMS Build 1.5 did not provide a smooth return to operations when recovering from system failures or erroneous actions. For example, one individual reported accidentally erasing the CET table by pressing the Escape key. Another user recommended providing the ability to stop processing when refreshing ArcView maps because they require significant processing time. This would enable the users to refresh the process if they had made a wrong selection. Many errors required the application to be reloaded, and, in some instances, it was necessary to reboot the workstation.

3.3.4 Minimum User Actions

This category addresses how the user takes actions and implements decisions. Users should not be forced to complete a number of actions to achieve a simple task. Minimum User Actions has two components – minimizing the number of actions required and minimizing the complexity of the action. These become more important as the system workload and stress levels increase. Complex behaviors tend to break down under stress before simple ones. Emphasizing minimum user actions can significantly reduce the risk of operational errors in a heavy-workload OCC environment.

This category generated 36 comments from users and observers. Most of these addressed the excessive number of actions required to accomplish a task. The phrase "too many steps" was used repeatedly. There were two main reasons reported for the excessive number of steps:

a. The application failed to auto-populate fields with data available in the system. This required the user to either search for and manually transfer data or reenter the data before the task could be completed. This slowed task performance and increased the opportunity for errors. Failure to transfer data from the CET to the ET was cited as a significant example.

b. Assigning a field specialist to an ET required several steps to locate personnel and then to make the assignment. Much of the data and parameters (e.g., whether the normally assigned specialist is already assigned or whether call back is required) were already available to the system.

Action complexity refers to the difficulty resulting from how an action is performed. For example, a key press is less complex than entering text or locating an object on a graphic display, centering a trackball tag over it, and then clicking. In this evaluation, the primary issue raised was the need to manually enter text rather than selecting it from a short list or having other alternatives available. Another case of unwanted complexity was the need to enter the word DATE in parentheses before actually entering the date. Because this is a date field, the system should recognize the date without the preliminary entry.

The relatively large number of comments indicated that users perceived the required actions as excessive and interfering with accomplishing the tasks. The issue is particularly important as workload and system stress increase. When performance is most critical, failure to minimize actions required can result in serious performance degradation. The human factors engineers recommend that system software logic be considered for most of the searching and sorting tasks.

3.4 Data Display

Data display refers to the information presented on a computer terminal and may include text, graphics, or a combination of both. It is closely interrelated to the components addressed under Basic Screen Design and Operation (Section 3.2 of this document). The goal of any display is to communicate required information clearly and unambiguously to the user. Section 8.5 of the HFDG provides specific recommendations regarding the design of both text and graphics displays (Wagner et al., 1996).

3.4.1 Text

This area is restricted to the legibility of text in displays and the use of unique and descriptive labels. Consistency of wording and labeling, which are also aspects of text display, were addressed in Section 3.2.1 of this document. Users reported that text was clear and easy to read across all applications. They did not consider labeling, itself, a major issue. However, there were instances when unique labels were not provided and when labels reflected industry and not FAA terminology. The human factors engineers recommend that all labels be reviewed to verify they are unique, descriptive, and consistent with FAA usage.

3.4.2 Graphics

Graphics include pictures, geographic displays, diagrams, graphs, and charts. The intent of graphics is to “facilitate the detection of relationships among variables, comparisons among data sets, and the detection of trends in the data” according to the HFDG, Section 8.5.5 (Wagner et al., 1996, p 8-107). The most extensive use of graphics in the NIMS Build 1.5 interface was the use of maps in ArcView. Most of the users indicated that these maps provided accurate service status information. However, the following issues were raised.

a. The sites appeared as dots without labels, and the users had difficulty differentiating them. This was more significant because users could not click on a site to access the ET. Instead, they had to identify the site in ArcView, go to MASS to determine the affected equipment, and then locate the associated CET from a long scrolling list.

b. The maps did not provide sufficient detail (e.g., streets).

c. Range circles could be added on top of each other without getting rid of the previous instance. This was confusing to the users, and they had difficulty clearing them.

d. Regional boundaries were not clearly visible.

The human factors engineers recommend that future systems provide easy access to site identification labels and associated ETs, additional map detail, and OCC boundaries. Guidelines for common map symbology are provided in *Symbol Standardization in Airway Facilities* (Ahlstrom, Cranston, Mogford, Ramakrishnan, & Birt, 1998).

3.5 User Access

The participants noted that some Maximo screens that they reviewed were not required for them to perform their current duties. For example, only Program Support Specialists and Systems Maintenance Office Managers require access to labor certifications (step 3.1p). The users were granted access to the entire system to enable them to evaluate consistency of screen design and data input methods across all modules and to view the types of information in the database. When fielded, it is anticipated that users would be authorized to access only those areas of the system that directly supported their duties.

One area of the system that raised significant concern was the ability to modify the status of a site in ArcView. For example, if a site was in alarm, any user could select that site and change the status to normal. Confirmation or verification of identity was not required. If the capability to change site status is present in the fielded version of the product, the human factors engineers recommend that the list of personnel authorized to make such a change be carefully reviewed.

3.6 Help

A good on-line help utility can significantly improve the usability of a system and can aid users in error recovery. However, the NIMS Build 1.5 test suite provided little on-line help to users. MASS and Maximo did not incorporate a help utility, and the information provided by ArcView was not FAA specific and, therefore, of limited value.

Human factors guidelines suggest that on-line help should always be accessible to the user, provide a context-sensitive search capability, and be sensitive to the context within which it was requested (Wagner et al., 1996). Weinschenk and Yeo (1995) indicate that online help should include information that is urgent, specific, changed frequently, is complexly organized, or incorporates large amounts of reference information.

4. Conclusions

The purpose of this study was to evaluate the NIMS Build 1.5 Specialist interface. The human factors engineers aggregated the participant comments into human factors categories and identified those issues most likely to affect the ability of users to effectively perform their tasks.

This evaluation was subject to a number of known limitations, which could significantly affect performance and its evaluation. The software was still in development, so the three applications were not fully integrated and not all functionality was provided. Some of the users anticipated a more complete product, and this may have affected their evaluation. Only one user and one observer had previous training or experience with Maximo. Also, not all users had experience with the MASS software and none had been exposed to ArcView. Whereas the software and system were known to be incomplete, the human factors engineers considered the issues noted in this report to be relevant to any future development of a centralized AF maintenance monitoring and control system.

4.1 Major Issues

Based on the number of comments made in each of these categories, the human factors engineers identified four significant issues that warrant investigation. These areas include application integration, information availability, error messages and management, and feedback.

4.1.1 Application Integration

With three major, disparate applications involved, a significant issue is integrating these into a single functional system. Because two of these are COTS items from different vendors and one is government developed, there is little commonality in their underlying structures or approach to presentation of data and operational control. User and observer comments in several sections clearly indicated that there was insufficient transfer of data across the interfaces.

4.1.2 Information Availability

For the users in this evaluation, Maximo was the most extensively employed application and most comments addressed this software. In general, the users did not consider the data availability appropriate to their needs. As tested, they thought that the system contained extraneous and rarely used items on many screens. The result was that task completion was difficult, slower, and potentially error prone. Given the likelihood of high workload demands in a centralized monitoring and control facility, significant effort is warranted to define and design screen data content. This redesign should be based on detailed task analyses and extensive contact with AF personnel.

The users felt that the Build 1.5 version of Maximo was inadequately adapted to the FAA environment. Data presentation, data access, and terminology are examples of areas that need improvement.

4.1.3 Error Messages and Management

The users found error messages largely undecipherable. Most seemed to be directed at application programmers rather than at AF users. They gave the user little assistance in correcting the error. The users found that the software also appeared to have problems with certain kinds of error detection. A number of fields were found that would accept incorrect entries without warning the user. In general, error messages, detection, and management need significant attention before this program is fielded.

4.1.4 Feedback

The users indicated that the lack of feedback to their inputs and actions was a major issue. For many user actions, there was no way to determine if the action had been accepted or if there was a failure due to an input error or a system problem. Immediate feedback as to the success of an action or the state of the system in performing some extended function is critical to successful system performance.

4.2 Overall Conclusions

The issues identified in the current evaluation are typical of those that should be addressed in any system intended to function in a remote monitoring and control facility. At its tested maturity level, Build 1.5 was not capable of supporting an OCC Specialist in an operational environment. This evaluation identified many areas that need improvement. In spite of these limitations, some of the users felt that Build 1.5 could be improved to meet their needs. The major issues identified were application integration, information availability, error messages and management, and feedback. The human factors engineers concluded that the majority of issues identified in this evaluation could be mitigated through the application of sound human engineering principles.

References

Ahlstrom, V., Cranston, R. L., Mogford, R., Ramakrishnan, A., & Birt, J. (1998). *Symbol Standardization in Airway Facilities* (DOT/FAA/CT/TN98/20). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

Federal Aviation Administration (September, 1997). *Concept for NAS infrastructure operations and maintenance (*Draft*).* Washington, DC: Federal Aviation Administration.

Federal Aviation Administration (1998a). *National Airspace System (NAS) Infrastructure Management System (NIMS) Premier Facility (NPF) integration test plan and procedures: draft* (98-ISC-04). Upper Marlboro, MD: Raytheon.

Federal Aviation Administration (1998b). *National Airspace System (NAS) Infrastructure Management System (NIMS) Premier Facility (NPF) utilization plan: draft* (DMC-98-IS-001). Washington, DC: Federal Aviation Administration.

Federal Aviation Administration (1998c)*. National Airspace System (NAS) infrastructure management system (NIMS) System/Segment Specifications (SSS)*. Washington, DC: FAA.

Shneiderman, B. (1992). *Designing the user interface: strategies for effective human-computer interaction (2nd ed.).* New York: Addison-Wesley.

Wagner, D., Birt, J. A., Snyder, M. D., & Duncanson, J. P. (1996). *Human factors design guide for acquisition of commercial-off-the-shelf subsystems, non-developmental items, and developmental systems* (DOT/FAA/CT-96/1). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

Weinschenk, S., & Yeo, S. C. (1995). *Guidelines for enterprise-wide GUI design*. New York, NY: John Wiley & Sons.

Appendix A

CHI Evaluation Test Scripts

1.0 MASS familiarization

Description:

This test will provide familiarization with the start up and operation of MASS.

Objective:

To become familiar with the function and operation of MASS.

Limitations:

The events will be induced using a non-operational database.

Input:

COTS software, FAA provided software, configuration information.

Output:

Alarm indication in the MASS table.

Success Criteria:

User should be able to acknowledge, mask, and filter alarms.

Procedures:

Test Steps:	**Expected Results:**	**Comments:**
1.0 System Logon		
a) Press **Ctrl+Alt+Delete** and then "**OK**".	Logon dialog box	
b) Depending on position, use one of the following logons for both the USERID and PASSWORD: **occuser1, occuser2, occuser3, noccuser, socuser, or wcuser.**	**Caution logon is case sensitive **	
1.1. MASS client log on		
a) Launch MASS by clicking on the **MASS** icon.	MASS logon window is displayed.	

Test Steps:	Expected Results:	Comments:
b) Enter USERID (**ea27coc**) and PASSWORD (**PASSWORD**) in logon window, click on **OK** button.	**Caution logon is case sensitive ** System Monitor window displayed. Alarms list is displayed in the event log.	
c) Maximize both windows.	Information about alarm event include: 1. Cnt: *(Alarm Count)* 2. PR: *(Priority)* 3. Status: * 4. Site: *(Facility Ident)* 5. Type: *(Facility Type)* 6. LUID: *(Logical Unit & ID#)* Cr: *(Criticality)* Roll-up *(+) = more than one event.* Parameter Description: Event level *(Low, Actual, high)*	*** A = Alarm** **a = Alert** **N = Normal** **S = Status message** **Check = Acknowledged**
d) Select an unacknowledged alarm/alert from the list and click on the **Acknowledge Alarm** Icon (checkmark symbol) in the toolbar.	Alarms/Alert dialog box is displayed	
e) Select **alarm/alert** from Alarm & Alert dialog box and click "**OK**".	Observe the alarm is acknowledged and the list is updated.	
f) Click on the "Mask" Icon in toolbar.	The Mask dialog box will be displayed. This function is used to enable alarm/alert masks for a specific time frame on the facilities and parameters selected	
g) Click "**CANCEL**"	The mask dialog box closes.	
h) Click **on** the "**Filter**" Icon in toolbar.	The filter dialog box is displayed.	
i) Double click on the **Acknowledged Alarms and Alerts** in the Condition Box	Acknowledged alarms and alerts are displayed in the Filter Box.	
j) Click "**OK**"	Acknowledged alarms/alerts are filtered and not displayed in list.	
k) Click on the Alarms list, Site List, and Unack list.	Each list type is displayed.	

2.0 ArcView familiarization

Description:

ArcView provides a graphic representation of alarm/alert status of the NAS. This procedure will provide familiarization with the start up and operation of ArcView.

Objective:

To become familiar with the function and operation of ArcView.

Limitations:

Only non-intrusive events will be induced using non-operational systems.

Input:

COTS software, FAA provided software, configuration information.

Output:

Alarm indications on graphic display, facility information, and display feature customization.

Success Criteria:

User should be able to configure a display to view desired alarms and retrieve facility information.

Procedures:

Test Steps:	**Expected Results:**	**Comments:**
2.0 System Logon		
a) Press **Ctrl+Alt+Delete** and then "**OK**".	Logon dialog box	
b) Depending on position, use one of the following logons for both the USERID and PASSWORD: **occuser1, occuser2, occuser3, noccuser, socuser, or wcuser.**	**Caution logon is case sensitive **	
2.1. Arcview client log on		
a) Double click **Internet Explorer** Icon.	NPF window is displayed.	
b) Click on "**National Facilities Monitoring Display**" hyperlink.	ArcView logon box is displayed.	

Test Steps:	Expected Results:	Comments:
c) Enter the USERID and PASSWORD entered in step 2.0 b press “**OK.**”	Allow approx. 15 minutes for application to load.	
d) Select and then Deselect each item in the Main View toolbox on the left side of the screen.	Observe the changes in the display presentation.	
e) Select the **Add Group** Icon from the top left hand corner of the tool menu.	Drop down list is displayed.	
f) From drop down lists Select: Terminal – “OK” Radar – “OK” Remote – “OK”	Allow approx. 1 minute for the Radar group to be added to the system.	
g) Select **ASR check box** in menu area on left side.		
h) Select the **Zoom In** icon from the tool bar (+). Click and Drag the tool to around the Washington DC area, including Northern VA (Dulles).	Magnified view of the area selected should be displayed.	
i) Adjust the ICON size using the “**Increase Icon**” and “**Decrease Icon**” Icon in the toolbar.	Facility Icons change size.	
j) Select the **ASR check box area.**	A raised box should appear around the ASR checkbox.	
k) Click on the “**i**” (information) Icon in toolbar and place it over the center of a facility icon on the graphic display. **Click**	Facility information dialog box is displayed.	
l) Click on the “**Adjacent Radar**” Icon toolbar and place it over the center of a facility icon on the graphic display. **Click**	Adjacent radar coverage area displayed.	
m) Select “**Display Areas**” from menu bar and **CONUS** from drop down list.	Graphic display reverts back to the CONUS view.	

3.0 Maximo familiarization

Description:

This test will provide familiarization with the start up and operation of Maximo.

Objective:

To become familiar with the function and operation of Maximo.

Limitations:

Only non-intrusive events will be induced using non-operational systems.

Input:

COTS software, FAA provided software, configuration information.

Success Criteria:

Become familiar with Maximo functional screens.

Procedures:

Test Steps:	Expected Results:	Comments:
3.0 System Logon		
a) Press **Ctrl+Alt+Delete** and then "**OK**".	Logon dialog box	
b) Depending on position, use one of the following logons for both the USERID and PASSWORD: **occuser1, occuser2, occuser3, noccuser, socuser, or wcuser.**	**Caution logon is case sensitive **	
3.1. Maximo client log on		
a) Double click **Internet Explorer** Icon.	NPF window is displayed.	
b) Click on "**Infrastructure Resource Management System**" hyperlink.	Maximo logon box is displayed.	
c) Enter the USERID and PASSWORD entered in step 3.0 b, press "OK."		
d) Select "**Event Ticket**" Icon and select "**Event Tickets Tracking**" from the drop down list.	Event Ticket screen is displayed.	

Test Steps:	Expected Results:	Comments:
e) Select **each tab** in the event ticket area and explore the fields.	Each tab will display the fields associated with that tab.	
f) Select the "**Event Ticket**" Icon from the menu on the left side of the screen. Select "**Candidate Event Tickets**" from the drop down list.	Candidate Event Ticket screen is displayed.	
g) Select **each tab** in the Candidate Event Ticket area and explore the fields.	Each tab will display the fields associated with that tab.	
h) Select the "**Preventive Maintenance**" Icon from the menu on the left side of the screen. Select "**Preventive Maintenance**" from the drop down list.	Preventive Maintenance screen is displayed.	
i) Select **each tab** in the Preventive Maintenance area and explore the fields.	Each tab will display the fields associated with that tab.	
j) Select the "**Equipment**" Icon from the menu on the left side of the screen. Select "**Equipment**" from the drop down list.	Equipment screen is displayed.	
k) Select **each tab** in the Equipment area and explore the fields.	Each tab will display the fields associated with that tab.	
l) Select the "**Equipment**" Icon from the menu on the left side of the screen. Select "**Operating Location**" from the drop down list.	Operating Location screen is displayed.	
m) Select **each tab** in the Operating Location area and explore the fields.	Each tab will display the fields associated with that tab.	
n) Select the "**Plans**" Icon from the menu on the left side of the screen. Select "**Job Plans**" from the drop down list.	Plans screen is displayed.	

Test Steps:	**Expected Results:**	**Comments:**
o) Select **each tab** in the Job Plans area and explore the fields.	Each tab will display the fields associated with that tab.	
p) Select the "**Labor**" Icon from the menu on the left side of the screen. Select "**Labor**" from the drop down list.	Labor screen is displayed.	
q) Select **each tab** in the Labor area and explore the fields.	Each tab will display the fields associated with that tab.	
r) Select the "**Labor**" Icon from the menu on the left side of the screen. Select "**Calendar**" from the drop down list.	Calendar screen is displayed.	
s) Select **each tab** and explore.		

4.0 Alarm Detection, Candidate Event Ticket Generation, and Event Ticket Generation.

Description:

- Simulate ASR-9 alarm from MASS
- View the alarm in ArcView
- Auto creation of Candidate Event Ticket (CET)
- Generation and population of an Event Ticket (ET)
- Simulated repair and event closure

Objective:

The objective of this test is to verify that a CET is automatically generated from a MASS alarm. An ET can be generated from a CET.

Limitations:

Only non-intrusive events will be induced using non-operational systems.

Input:

COTS software, FAA provided software, configuration information.

Output:

Facility alarm messages are populated in a Candidate Event Ticket.

Success Criteria:

Automatically populate alarm information in the Candidate Event Ticket fields.

Procedures:

Test Steps:	**Expected Results:**	**Comments:**
4.0 System Logon		
a) **MASS, ArcView, and Maximo** should be up and running before proceeding. Follow the System Logon procedures in scenario 1.0, 2.0, and 3.0.		
4.1 MASS Alarm		
a) Advise one of the NPF staff that a simulated ASR alarm is required.		
b) Observe the MASS alarm list and verify the alarm is generated.		

Test Steps:	Expected Results:	Comments:
c) Acknowledge the alarm in MASS by: **selecting the alarm** Clicking the **Acknowledge Icon, selecting the alarm in dialog box list,** and “**OK.**”	The alarm list should update indicating the change in status.	
d) Observe the alarm in ArcView: ensure the Terminal-Radar-Remote group is displayed. If not follow procedure 2.1.e		
e) Zoom in on the alarm using the **Zoom in** tool (+).		
f) Select the **ASR check box area.**	A raised box should appear around the ASR checkbox.	
g) Select the information Icon (**i**) and click on the facility alarm icon.	The facility details should be displayed.	
4.2 CET Generation		
a) In Maximo, Select the **Event Ticket** Icon and **Candidate Event Ticket** from the drop down list.	The CET Table is displayed.	
b) Verify that the ASR CET was generated for the alarm that was acknowledged in MASS.		
c) Select the **ASR CET** and select the “**CET Detail**” tab.	Review the Detail information.	
4.3. Overview the history CETs and running CET history report.		
a) Click on **CET Table** tab.		
b) To generate a history CET report, Select **File -Run Reports.**	CET Report window is displayed.	
c) Select the “**CETHIST**” report and “**Run**”.	SQR Option window is displayed.	
d) Select Preview option, “**OK**”.	“Parameters - CETHIST” window is displayed.	

Test Steps:	Expected Results:	Comments:
e) Enter the site location (**IAD**) and the site type (**ASR**), **at Start tab enter date**, and **at End tab enter date**. Click "**OK.**"	CET History Report is displayed.	
f) Review the report and Close it by clicking the lower "**X**" in the top right hand corner.		
g) Select the "**CET Table**" tab and select the **ASR CET.**		
h) Click on the "**Generate Event Ticket**" button. Select "**OK**" and "**YES**" to go to the ET.	Make note of the ticket #.	
4.4 Event ticket population.		
a) In the Event Ticket Details Box just to the Right of the ticket number enter "***YOUR NAME* ASR-9 Repair.**"		
b) In the Responsibility area click the select **Ticket Priority Detail** button (***) and "**3**" from the drop down list. "**OK**"		
c) Select the **OCC Specialist detail button (***)** to display the list of OCC Specialist and select one to the ticket. "**OK**"		
d) In job details area select event type and "**EM**" from the drop down list. "**OK**"		
e) Select outage class and "**FL**" from the drop down list. "**OK**"		
f) In Schedule Information area select **actual outage** details button. "**OK**"		
g) In Responsibility area select **Assign a Specialist**. And choose one from the list.		

Test Steps:	Expected Results:	Comments:
h) Select **Contact Specialist** and push **Page Method. "OK**". Close all pager associated dialog boxes and assume the specialist was successfully paged.	Assume the page was received and the specialist is responding.	
i) **Re-Select the specialist** and press **Make Assignment**. "**CLOSE**"	Make note of specialist's labor code.	
j) Select **Action-Change Status** from the menu bar and select **Approved**.		
k) Select **Electronic Log Notes** icon from the top tool bar and enter "**Specialist contacted and responding**". "**OK**"		
4.5 Specialist ET population.	Assume you are the specialist in the field.	
a) Select **View-Saved Queries** from the menu bar. Select the **specialist's labor code** from step J and hit **Execute.**	The first ticket assigned to this specialist is displayed.	
b) Select the **Global List** icon from the toolbar. All the open ET's assigned to this specialist are displayed. Select the ticket you generated. "**OK**".		
c) Select **Action-Change Status** from the menu bar and select **Inprogress.**	Note the status change.	
d) Select **Electronic Log Notes** icon from the top tool bar and enter "**system repaired and restored". "OK"**		
e) Select **Action-Change Status** from the menu bar and select **Completed.**	Note the status change.	
4.6 OCC Review and SER generation.		
a) Select **File-Run Reports-Electronic log notes** from the menu bar. "**RUN**"		

Test Steps:	**Expected Results:**	**Comments:**
b) Enter the **ticket number** from the ET generated 4.3.c. Also select the Application tab and enter **"WOTRACK**" -"**OK.**"	The log is displayed for review.	
c) Close the log by clicking the lower "**X**" in the top right hand corner.		
d) Click in the SER box and type "**Y**". Save file.		
e) Select **Create SER** pushbutton and populate SER fields (there are 3 tabs). When completed select **Publish Version.**		
f) Select **File-Run Reports-SER** from the menu bar**. Enter the ET #. "RUN"**	The SER is displayed.	
g) Close the SER by clicking the lower "**X**" in the top right hand corner.		
h) Select **Action-Change Status** from the menu bar and select **Close**.	Note status change.	

5.0 Building a New Event Ticket

Description:

This test will demonstrate preparing a new Event Ticket.

- Access Event Ticket Records
- Identify Job Operations
- Identify Labor
- Identify Needed Materials
- Identify Tools
- Assign Event Ticket
- Approve , Complete, and Close an Event Ticket

Objective:

The objective of this test is to demonstrate NPF capabilities of building a Event Ticket.

Requirements:

SLS637, SLS647, SLS648, SLS651

Limitations:

Not known at this time.

Input:

MAXIMO software, FAA provided software, configuration information.

Output:

Displays tools that are used to build Event tickets.

Success Criteria:

The NPF should provide tools to build Event Ticket.

Procedures:

Test Steps:	**Expected Results:**	**Comments:**
5.1. Access Event Ticket Records:		
a) From MAXIMO main menu, Click on "**Event Tickets**" module icon. Select "**Event Ticket Tracking**".	Event Ticket Tracking window is displayed.	
b) Click on "**Insert Record with AutoNumber**" button (far left icon on tool bar).	Event Ticket number field, Reported By Date field, Event Ticket Status field, and Status Date field are auto-populated.	

Test Steps:	Expected Results:	Comments:
c) Click on Location field detail button. Drilldown to the following location: **AEA-REG, CBS-SMO, IAD-SSC, IAD-SSC, and IAD-ASR. "OK".**	Drilldown window opens.	
d) In the Event Ticket Details Box just to the Right of the ticket number enter "***YOUR NAME* ASR-9 PM.**"		
e) In the Responsibility area click the select **Ticket Priority Detail** button (***) and "**2**" from the drop down list. "**OK**"		
f) Select the **OCC Specialist detail button (***)** to display the list of OCC Specialist and select one to the ticket. "**OK**"		
g) In job details area select event type and "**PM**" from the drop down list. "**OK**"		
h) Select outage class and "**FL**" from the drop down list. "**OK**"		
5.2. Identify Job Operations: (Plans)		
a) Click on the **detail button** in Job Plan field, select an existing job plan. "**OK**".	Plans window is opened. Job Plan field is auto-populated.	
b) Select **Plans tab**.	Operations steps, Labor, and Material sections are auto-populated.	
5.3. Assign Event Ticket:		
a) In Responsibility area, select **Assign a Specialist** and choose one from the list.	Record the specialist's labor code.	
b) Select the **Labor** icon and select **Calendars** from the drop down list.		
c) Type the **Specialist's labor code** into the **Calendars** field and "**ENTER**".		
d) Click on the **details button** (***) for today's date to get the Specialists shift details. "**OK**"		

Test Steps:	**Expected Results:**	**Comments:**
e) Select **Event Tickets** icon and **Event Ticket Tracking**.		
f) In Responsibility area select **Assign a Specialist**. And choose one from the list and select **Make Assignment. "OK"**		
5.4. Event Ticket status changes:		
a) Click **on Action-Change Status**. Select **Approved.**		
b) Enter a Scheduled Start time by clicking on **detail button and "OK**".		
c) Enter an Estimated Duration for the event.		
d) Click on **Action-Change Status**. Select **Initiate.**	Initiate window is displayed.	
f) Click on **Actuals** tab.	Actuals window is displayed. Operations fields are auto-populated from the job plan.	
g) Click on the **Labor** sub-tab and then click **OPS** field on the first line. Click the **detail button** and **select an item** from the drop down list.	The Select Value window is displayed with a list of specialist.	
h) **Tab** to next field and **select Specialist.**	Labor Code field is auto-populated with "CE02RP."	
i) **Tab** to name field.	Field auto-populates.	
j) **Tab to Start Time** and enter start time; **tab to Finish** Time and enter finish time.	Hours field and line cost field auto-populates.	
k) Click on ET tab and then click on **Action - Change Status.** Select **Complete.**	Complete window is displayed.	
l) Click on **Cost** tab and review information.		
l) Click on **Action - Change Status**. Select **Close.**	Close window is displayed.	OCC will close after all coordination is completed.
m) Select **Action-View status history**.	The Ticket Status history is displayed.	

6.0 Work Force Schedule Creation and Tracking

Description:

The NPF should provide tools to create and track work force schedule.

Objective:

The objective of this test is to verify that NPF demonstrates capabilities of work force schedule creation and tracking.

Requirements:

SLS627

Limitations:

Only non-intrusive events will be induced using non operational systems.

Input:

COTS software, FAA provided software, configuration information.

Output:

Displays calendar with listings of work periods, date, shifts, and holidays.

Success Criteria:

The NPF provides means to demonstrate work force schedule tracking.

Procedures:

Test Steps:	**Expected Results:**	**Comments:**
6.1 Creating a shift:		
a) Click **Labor** icon on Maximo main menu.	Labor Application menu displays following selection: Labor Labor Reporting Calendars Work Assignment Queue	
b) Select **Calendars**	Calendars window displays. Default screen is the Calendar tab screen.	
c) Select **Actions -Define/Apply Shifts**	Define/Apply Shifts window opens.	
d) Click **Insert Row** button and enter a shift name (i.e., your initials).		
e) **Tab** to next field and enter a shift description (i.e., test schedule).		

Test Steps:	Expected Results:	Comments:
f) **Tab** to next field and enter a Start Day by clicking on detail button and selecting a day from the list, “OK”.		
g) **Tab** to next field and enter days in the shift pattern and click save.		
h) Highlight the newly entered shift row and click on **Define Pattern**.	Define Shift Pattern window opens.	
i) **Enter Start Time and End Time** for each day of the pattern. Tab past days off (not worked).		
j) When all days of pattern are completed, click on **OK** and then **Close.**		
6.2 Creating a calendar:		
a) Click on **Calendar** tab and then click on **Insert icon** on tool bar (top left).		
b) **Enter a calendar name** (i.e., your first name) in the Calendar field and press **tab.**		
c**) Enter a short description** of the calendar and then **tab** to next field.		
d) **Enter a start date** by clicking on the detail button and selecting a start day and then **OK**.		
e) **Tab** to the End Date and enter a **End date** by clicking on the detail button and selecting a end day, click **OK**, and press **tab** key.		
f) Click **Save** icon on tool bar.		
g) Select **Action - Define/Apply Shifts**	Define/Apply Shifts window opens.	
h) Select the previously created shift and click on **Apply Shifts** button.	Apply Shifts window opens.	
i) Click **OK** and the close Define/Apply Shifts window by clicking on “**X**” in upper right corner.	Calendar is populated with shift data**.**	The number displayed by each day of the month is the number of hours worked.
j) Choose a day and click on the **detail** button.	The View/Modify Work Periods window opens, displaying the work schedule for that day.	
k) Click **OK** to return to Calendar.		

Test Steps:	Expected Results:	Comments:
6.3 Modifying Calendar by Adding Holidays:		
a) Select **Action - Define/Apply Holidays.**	Define/Apply Holidays window opens.	
b) Select the appropriate holiday and click **Apply Holidays**.	Apply Holidays window opens.	
c) Click **OK** and then **cancel** to close Define/Apply Holidays window.	Observe that the holiday date displays 0 hours worked.	
d) Highlight holiday day and click on **detail** button. "**OK**".	View/Modify Work Periods window opens, displaying "Holiday".	
6.4 Modify Calendar by Adding Non-work day.		
a) Click on **Actions - Apply Non-Working Time.**	Apply Non-Working Time window opens.	
b) Click on **detail** button in Non-Working Type field and select a type and click **OK.**		
c) Click on **detail** button in Start Date field and select a start date from the Date/Time calendar window, and click **OK.**		
d) Click on **detail** button in End Date field and select a end date from the Date/Time calendar window, and click **OK.**		
e) Click **OK** in the Apply Non-Working Time window.	Non-working time displayed on calendar as 0 work hours for each day identified.	
f) Click **Work Periods** tab to display schedule in a tabular format.		

Appendix B

Post-Usability Evaluation Questionnaire

NIMS Build 1.5 Usability Questionnaire

Purpose:

The following questions are designed to assess your opinion of the usability of NIMS Build 1.5 in support of your AF duties.

Instructions:

1. Read each item carefully. Please restrict your answers to NIMS version 1.5.
2. **Check** the box that most accurately reflects your experience using NIMS Build 1.5. Each item provides a statement followed by 2 choices--either **True**, or **False**. If you found that a feature was unacceptable at any time during the evaluation, please choose **False** as your response and explain the circumstances.
3. A comment field is provided for each item. Please provide any additional information you can to explain your response. We encourage you to complete this section since it will provide valuable insights into the usability of the system.
4. If you have any questions, or do not understand an item, please contact the usability evaluation administrator.

The information you provide will be anonymous and kept strictly confidential.

Thank you for your participation.

Participant Background

1. What is your current job title? ____

2. What location/facility are you currently assigned to? __________________________________

3. What equipment/systems are you certified to maintain? _________________________________

   ____

4. How much experience do you have as an AF Specialist? Years: ________ Months: ____________

5. How much experience do you have using NIMS? Weeks: _______ Days: ______________

6. Have you participated in previous NIMS evaluations? Yes _____ No _____

   If so, when? Date: _____________________ Which Version? ______________________________

7. What do you feel is your computer experience level?

   beginner ________ intermediate __________ advanced __________ expert ____________

8. Have you received training on NIMS? Yes _____ No _____ If so, when? Date: _________________

   What type of training did you receive? Please check each that applies.

   Classroom _____ Hands on _____ Other (please specify): ______________________________

9. Is there anything else we should know regarding your participation in this assessment? ______________

   ____

   ____

   ____

Item	True	False	Comments
I. Visual Displays			
1. Coding is used effectively (e.g.., color, highlighting, bolding).			
2. Display clutter is not a problem (i.e., information that is presented is necessary and well organized).			
3. The meaning of each label is immediately apparent.			
4. Labels have the same meanings as current systems.			
5. Information that you need is readily available and well organized.			
6. The design provides all the necessary information for a specific task when it is needed and in the appropriate sequence.			
7. The design minimizes visual attention to display locations that will interfere with attention to high priority tasks.			
8. The design promotes situational awareness and service status information.			
9. Text is clear and easy to read.			
10. Visual alerts are easy to see and understand.			
11. The computer responds quickly and you are not kept waiting for information.			
12. I was always aware of what the system was doing.			
13. After system recovery from degradation or failure, a smooth return to operation is possible.			
II. Data Entry			
14. The system provides guidance regarding data input restrictions.			
15. The data entry method(s) helps to minimize errors.			
16. It is easy to detect errors in data entry.			
17. It is easy to correct errors in data entry.			
18. The number of keystrokes (or other control actions) necessary to input data is kept to a minimum.			
19. The amount and complexity of data entry is about the same as what you are used to.			
20. The menus are easy to use and do not provide too many options/levels.			
21. The menu options are easy to understand.			
22. It is easy to know where to find command.			
23. Menu options are arranged in a logical order with the most frequently performed functions at the top.			

Item	True	False	Comments
III. Error Messages and User Guidance			
24. Error messages are clear and easy to understand.			
25. Each error message briefly summarizes the specific problem and proposes a specific solution.			
26. On-line help is easily accessed.			
27. On-line help is easy to use and up-to-date.			
IV. Data Input and Control Devices			
28. The input device(s) is/are appropriate for performing the necessary functions (e.g., alphanumeric data entry, use of windows, cursor positioning).			
29. The keyboard is easy to use.			
30. The mouse is easy to use.			
31. Function keys are provided for frequently used commands.			
V. Functionality			
32. The system design supports mobile users in disconnected mode.			
33. The system design supports your ability to generate Event Tickets.			
34. The system design supports your ability to monitor the status of maintenance activities (i.e., scheduled and unscheduled maintenance).			
35. The system design supports your ability to monitor the status of AT services.			
36. The system supports your ability to control remote AF facilities.			
37. The system design supports your ability to effectively manage resources (i.e., identify certified personnel, assign personnel, and locate equipment).			
38. The system design promotes your ability to communicate effectively (i.e., cc:Mail, phone, or beeper).			
39. The system design promotes your ability to coordinate effectively (i.e contact field/AT personnel, coordinate support, obtain approval).			
40. The system design supports your ability to generate reports.			
41. The system provides electronic access to documents (e.g., facility layout drawings, and technical specifications).			
42. The system provides a geographic display (i.e., map) with accurate service status information.			
43. The amount of available functionality is adequate.			

Item	True	False	Comments
VI. General			
44. The system is easy to learn and use.			
45. It is easy to navigate windows/modules.			
46. Overall, I am satisfied with the functions I used.			
47. Overall, the current design is acceptable.			
VII. General Comments			
48. Please provide any additional comments pertaining to NIMS Build 1.5: ______________________________ ______________________________ ______________________________			